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Dyeing of Silk with Eco-Friendly Natural Dyes obtained from the Flower of *Russelia equisetiformis* using Single Mordants

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Abstract

The sample silk fabric was dyed with natural dyes obtained from the flower of Russelia equisetiformis The colour fastness properties and colour strength of dyed silk fabric were determined and compared. From the comparative study of fastness properties and colour strength of the dyed silk samples, Russelia equisetiformis in simultaneous mordanting method with 3% mordant combination gives better results.

Keywords: *Colour strength; fastness; mordant; natural dye; Russelia equisetiformis.*

1. INTRODUCTION

The present scenario is focused more towards the utilization of the vast diversity of natural resources of color pigments for their use in food materials, pharmaceuticals and textiles, in place of their synthetic counterparts. This trend is aimed at safeguarding human health as well as protecting and prolonging life on earth.

Due to increasing awareness of environmental issues and also pollution produced by synthetic dyes, wide spread interest has emerged in the dyeing of textile fibres using natural colorants on account of their better biodegradability and higher compatibility. This research aim is to extract the eco-friendly natural dye obtained from the flower of Russelia equisetiformis apply on silk fabrics using single mordants. The fastness properties of the flower of Russelia equisetiformis dyed silk fabrics have been studied using different concentrations (1%, 2% and 3%). The wash, rub, light and perspiration fastness of the dyed samples have been evaluated.

However, recently the interest in the use of natural dyes has been growing rapidly due to the result of stringent environmental standards imposed by many countries in response to toxic and allergic reactions associated with synthetic dyes (Anderson, 1971; Samanta *et al.*. 2007; Sandeep Bains *et al.*. 2005).

Hence, due to the current eco-consciousness, the researcher's attention has been shifted to the use of natural dyes for dyeing textile materials (Sandeep Bains, 2003; Kumaresan *et al.*. 2010; 2011).

2. MATERIALS & METHODS

The present investigation deals with the extraction of natural dye from the flower of *Russelia equisetiformis*. The present investigation deals with the extraction of natural dye from the flower of *Russelia equisetiformis*

Bleached silk fabric obtained from Gandhigram Rural University, Dindugal**,** was used for the study.

Fig.1: Flower of Russelia equisetiformis

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Analytical reagents (AR) grade ferrous sulphate, aluminium sulphate, nickel sulphate, potassium dichromate, stannous chloride, commercial grade acetic acid, common salt, sodium carbonate were used. A natural mordant myrobolan (*Terminalia chebula*) powder (Kumaresan *et al.* 2011; 2012a) was used for the study. The ethanol extract of the flower of *Russelia equisetiformis* was used to get brown colour component for dyeing of fabrics. Depending upon the mordant used, the colour obtained on textiles from the flower of *Russelia equisetiformis* extract may give different shades.

A known quantity of flower of *Russelia equisetiformis* was dried, powdered and soaked in warm water overnight. The colour extract was obtained by boiling it in the same water. This dye extract was allowed to cool, finally filtered and used for dyeing. The dyeing was carried out at optimized dyeing conditions: dye extraction time 60min, material-to-liquor ratio 1:20, temp. 60 ^{0}C, wave length 420 nm and dyeing time 50 min.

The mordant combinations, viz. myrobolan: nickel sulphate, myrobolan: aluminium sulphate, myrobolan: potassium dichromate, myrobolan: ferrous sulphate, myrobolan: stannous chloride were used each in 1%,2% and 3%. The total amount of two mordants used in each combination was 5% owf, i.e. 5 g of the mordant / 100 g of the fabric. Each of the five mordant combinations in three different ratios mentioned above was used with all the three mordanting methods, namely pre-mordanting, simultaneous mordanting and post-mordanting for dyeing (Kumaresan *et al.* 2012b).

Colour fastness to washing[11,12] of the dyed fabric samples was determined as per IS: 764 – 1984 method using a Sasmira launder-O-meter following IS-3 wash fastness method. The wash fastness rating was assessed using grey scale as per ISO-05-A02 (loss of shade depth) and ISO-105-AO3 (extent of staining) and the same was cross-checked by measuring the loss of depth of colour and staining using Macbeth 2020 plus computer-aided colour measurement system attached with relevant software. Colour fastness to rubbing (dry and wet) was assessed as per IS: 766-1984 method using a manually operated crock meter and grey scale as per ISO-105-AO3 (extent of staining).

Colour fastness to exposure to light was determined as per IS: 2454-1984 method. The sample was exposed to UV light in a Shirley MBTF Microsal fade-O-meter (having 500 watt Philips mercury bulb tungsten filament lamp simulating day light) along with the eight blue wool standards (BS1006: BOI: 1978). The fading of each sample was observed against the fading of blue wool standards (1-8).

Colour fastness to perspiration[13,14,15] was assessed according to IS 971-1983, composite specimen was prepared by placing the test specimen between two adjacent pieces of silk and stitched all among four sides. The sample was soaked in the test solution (acidic /alkaline) separately with MLR 1:50 for 30 min at room temperature. The sample was then placed between two glass plates of perspirometer under load of 4.5kg (10 lbs). The apparatus was kept in the oven for 4 h at 37±2˚C. At the end of this period, the specimen was removed and dried in air at a temperature not exceeding 60˚C. The test samples were graded for change in colour and staining using grey scales.

All the treated samples subjected to light show fairly good (3-4) light fastness for all mordant combinations. The wash fastness grades range between 3 and 4 for all of the treated samples and there is no colour staining observed.

The colour change to dry and wet rubbing for all the treated samples is found to be excellent (5). There is a variation from no colour staining to negligible colour staining (5 to 4-5) in dry rubbing. Most of the treated samples show excellent fastness grade to colour change in both acidic and alkaline media. There is no colour staining (5) observed for all the treated samples in both acidic and alkaline media (Table 1). For the present study, three different combinations of mordants such as 1%,2% and 3% were prepared by mixing the natural mordant myrobolan with five inorganic mordants and dyed on silk fabrics. The colour fastness and colour strength values of dyed silk fabrics by using various combinations of mordants obtained in the present study and the values obtained by the earlier researchers are presented in Table 1, 2, 3 and 4. In all the three methods of dyeing using three plant parts, the mordants ferrous sulphate and aluminium sulphate showed excellent results.

From the comparison of colour strength results, it is clear that among the three mordant combinations 3% mordant combination is found to be better for dyeing. Comparing the three dyeing methods, simultaneous method in all two natural dyes gave excellent results.

Similar results were obtained in the previous study reported by Surabhi mahajan *et al.* (2005). Analysis of data from the Table 4 indicates that higher the concentration of mordants the higher will be the K/S value (Pan *et al.* 2003).A better light fastness (GS : 4-5) was observed in the present study compared to Kumaresan (2015) study when stannous chloride (GS : 2) was used as a mordant in premordanting method.

Table 1. Surface colour strength of flower of *Russelia equisetiformis* dyed silk fabric after pre, simultaneous and post mordanting methods by using 1% mordant concentration (K/S value without mordant : silk-1.29)

Mordant concentration:1%	K/S(λ=420 nm)		
	Pre mordanting	Simultaneous mordanting	Post mordanting
Nickel sulphate	1.22	2.34	2.01
Aluminium sulphate	1.60	2.44	2.48
Potassium dichromate	1.14	1.19	1.15
Ferrous sulphate	1.65	2.56	2.56
Stannous chloride	1.40	2.41	2.22
Myrobolan	0.91	1.20	1.26

Table 2. Surface colour strength of flower of *Russelia equisetiformis* dyed cotton fabric after pre, simultaneous and post mordanting methods by using 2% mordant concentration (K/S value without mordant : silk-1.29)

Mordant concentration:1%	K/S(λ=420 nm)		
	Pre mordanting	Simultaneous mordanting	Post mordanting
Nickel sulphate	1.22	2.40	2.06
Aluminium sulphate	1.67	2.54	2.56
Potassium dichromate	1.21	1.29	1.24
Ferrous sulphate	1.78	2.74	2.65
Stannous chloride	1.41	2.49	2.30
Myrobolan	1.01	1.30	1.28

Table 3. Surface colour strength of flower of *Russelia equisetiformis* dyed cotton fabric after pre, simultaneous and post mordanting methods by using 3% mordant concentration (K/S value without mordant : silk-1.29)

Mordant concentration:1%	K/S(λ=420 nm)		
	Pre mordanting	Simultaneous mordanting	Post mordanting
Nickel sulphate	1.21	2.38	2.04
Aluminium sulphate	1.64	2.51	2.51
Potassium dichromate	1.20	1.25	1.20
Ferrous sulphate	1.71	2.65	2.59
Stannous chloride	1.42	2.46	2.26
Myrobolan	1.01	1.29	1.30

Table 4. Comparison of fastness properties of dyed cotton using single mordants

Plant parts used for dyeing	Mordant used	Method	Properties						Reference
			WF	LF	RF		PF		
					Dry	Wet	Acidic	Alkaline	
Flower of *Russelia equisetiformis*	Ferrous sulphate (3%)	SM	4-5	4	5	5	5	4	Present Study
		PM	5	7	5	5	5	**4**	
	Aluminium sulphate (3%)	SM	4-5	5	4	4-5	5	4-5	
		PM	4-5	6	**4**	5	4	4	
Stem of *Achras sapota*	Ferrous sulphate (3%)	SM	5	4	5	5	5	5	Kumaresan *et al.* (2016)
		PM	5	4	5	5	5	5	
	Aluminium sulphate (3%)	SM	4-5	4	5	5	5	5	
		PM	5	4	5	5	4	4	
Flower of *Cordia sebestena*	Ferrous sulphate (3%)	SM	5	5	5	5	5	5	Kumaresan *et al.* (2017)
		PM	5	5	5	5	5	5	
	Aluminium sulphate (3%)	SM	4	5	5	4	4	4	
		PM	5	4	5	5	5	5	
Onosma echioides	Ferrous sulphate (3%)	SM	5	2	5	5	4	5	Sandeep bains *et al.* (2003)
	Aluminium sulphate (5%)	SM	5	2	4	3-4	5	5	
Fountain flower	Ferrous sulphate (3%)	SM	4-5	5	4-5	4	4-5	4-5	Shilpa mudgal and Geeta mahale (2002)
Mangifera indica	Ferrous sulphate (2.5%)	SM	5	4	4-5	4	5	5	Bains *et al.* (2003)
	Aluminium sulphate (12.5%)	SM	5	4	4-5	4	5	5	
Colquhounia coccinea	Ferrous sulphate (2.5%)	PM	4-5	4-5	5	5	5	5	Vankar *et al.* (2010)
	Aluminium sulphate (12.5%)	PM	4	4	4	4	4	4	
Pongamia pinnato	Ferrous sulphate (2.5%)	SM	-	5	4-5	4-5	-	-	Kumar *et al.* (2004)
	Aluminium sulphate (12.5%)	SM	-	5	4-5	4-5	-	-	
Neem tree bark	Aluminium sulphate (12.5%)	PM	3	2-3	4-5	4-5	-	-	Boonroeng *et al.* (2009)

WF-Wash fastness; LF-Light fastness; PF-Perspiration fastness; RF-Rub fastness; CS-Colour strength; PM-Pre mordanting; SM-Simultaneous mordanting.

Similar results were obtained in the previous study reported by Das *et al.* (2008) and Kumaresan *et al.* (2012). The present study shows excellent wash fastness (GS : 5) and light fastness (GS :5) when compared with Vankar *et al.* (2010). A better light fastness (GS : 7) was reported in the present syudy in simultaneous mordanting method.

4. CONCLUSION

From the comparative study of fastness properties and colour strength of the dyed cotton samples, flower of *Russelia equisetiformis.* in simultaneous mordanting method with 3% mordant combination gives better results.

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